Strategies for Improving IB Joint Tolerances and Strength to Achieve WT Joint Performance

NEW PRODUCTS & ENGINEERING

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DATE:

If ADS were able to design a reliable, watertight (ASTM D 3212 10.8 psi) inline bell (IB) joint, there could be significant cost savings related to the elimination of bells that are currently injection or blow-molded. Our current IB joint was designed to provide an outstanding silt-tight joint at minimal cost (short bells, small gaskets). In order to upgrade to a watertight IB joint, we need to address the issues of **TOLERANCES** and **BELL STRENGTH**. The tolerance issue can be addressed by revising the joint geometry (longer bells, more lead-in), using larger gaskets (with a wider sealing range) and possibly by enhancing plant QC procedures during manufacturing. To improve bell strength, there is a long list of alternatives that we might choose to pursue.

Ways to Manage Tolerance Requirements

Our Manufacturing Group has done a very good job of improving compliance rates with our current IB bell and spigot OD tolerances. Our latest summary of lab samples submitted between September and December of 1999 indicated 88% of Ultra samples complied with the dimensional specifications. This is a significant improvement over earlier periods. These improvements are primarily attributable to more conscientious manufacturing, with processing experience and some minor tooling modifications helping as well. Continuous improvement should be our expectation into the future, but these incremental improvements alone will not be sufficient to insure that every stick off each production line will meet watertight tolerances. There is a big difference between molding to a tolerance in a single injection mold in a single location with prime resin compared with extrusion on multiple lines in multiple locations with wide-spec resin and differing tooling setups. We'll have to employ some combination of other measures:

- Larger gaskets - the sealing range of gaskets are primarily determined by their size. If we design a joint to incorporate "taller" gaskets, we can accommodate wider bell and spigot tolerances. Unfortunately, larger gaskets will need significantly larger lead-in sections to facilitate assembly. This could mean either shorter spigot mini-corrugations or bell OD's that exceed our pipe OD (and again require bell holes and special onsite storage procedures). This is probably the safest, easiest way t tackle the tolerance issue. Gaskets would be more expensive and more difficult to install - bell should probably be longer as well which would effect laying lengths.
- 100% Inspection - A simple strategy to improve tolerances would be to simply measure every stick made, and designate some WT and some ST based on their dimensions. We would still need to redesign the IB joint geometry, but this would provide an outlet other than the grinder for non-compliant WT IB product.
- Resin Reinforcement / Additives - most "impurities" will reduce the shrinkage of PE thereby improving tolerances. This would include glass fibers, wollastonite, calcium and foaming agents. Tolerance benefits can be significant, and in the instance of glass fibers bell strength would be enhanced as well. The primary downsides are cost, process development efforts, inability to rework

scrap (possibly) and having to reinforce the entire pipe rather than just the joint. It would be nearly impossible to get AASHTO to accept fillers other than perhaps glass fibers that truly reinforce.

- Post Molding Bell Resizing - theoretically we could design equipment to reheat and resize the bells over a mandrel to ensure exact ID dimensions. This is likely to be slow and cumbersome.
- Electro-Fusion Joints - Some high-end pipe products employ electrofused joints - special welding rod with heating elements are used in place of gaskets. Once assembled in the field, the joint is "activated" by a portable power source and the bell and spigot are automatically welded together. Ultimately, this would yield a sealed joint but the product cost and development costs are probably prohibitive to the storm sewer market.

Ways to Improve Bell Rigidity

Currently, the standard for proving your product is "watertight" is ASTM D 3212 that requires testing at 10.8 psi. Unfortunately, PE expands slowly under pressure. When a bell is not thick enough, it "grows" until it leaks. This is what currently happens with our current IB bells during testing for approximately 24" and larger sizes. Some options for overcoming this challenge include:

- Thicker bells
  - Pull both layers of the dual wall extrusion together in the bell. This is a feature promised in the past by Drossbach and currently offered by Corma and Hegler.
  - Add a post-forming reinforcing ring to the bell OD - this might be an extruded ribbon, a fiberglass band, a mechanical fastener, or a welded ring of some sort. This may be the most practical approach.
  - Employ an "accumulator" on the extruder to make the bells thicker without adding weight to all 20-feet of pipe.
  - Add an ID reinforcing ring with or without an integrated bell gasket - similar to our last cleated prototype IB joint.
- Stronger Resin
  - HMW PE would give incremental improvement
  - Glass-Reinforced PE or PP would be significantly stronger
- Redefine "Watertight"
  - ADS could choose to promote a different (lower) standard for defining "WT" performance. This would be very difficult at best and would not be accepted in some markets for sure.

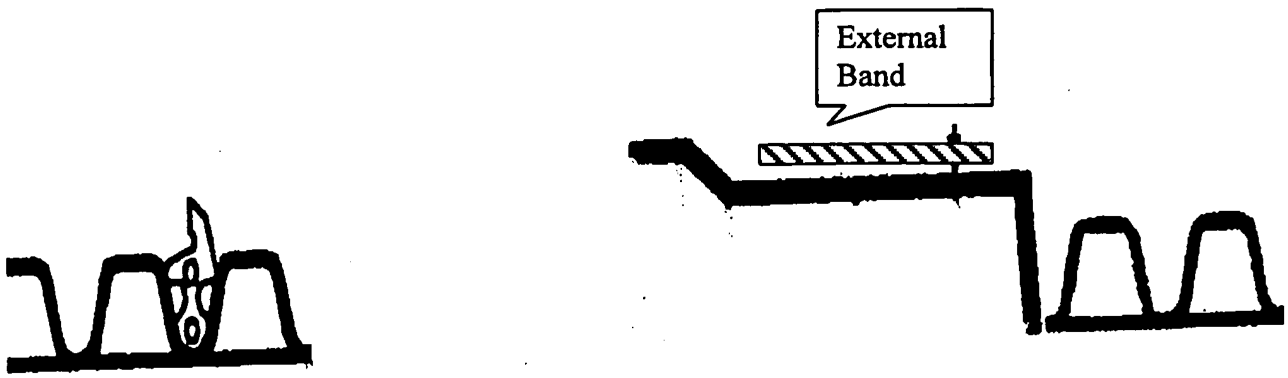
Conclusions

Watertight IB is achievable, and there will be added costs to both developing and producing WT IB when compared with our current ST IB pipe. The things that must happen are:

1. New Coupler Geometry - bells must have longer gasket seating areas, much larger flares, and potentially OD's larger than the pipe OD's. This is true for every size, and will require new bell and spigot tooling.
2. Larger Gaskets - Once the bells have a larger flare, we'll be able to squeeze more rubber into the joints to seal over a wider range.
3. Stronger Bells - for all sizes larger than 24" (and possibly 18") the bells will need to be reinforced. This could be accomplished in a number of ways.
4. Strict QC - Currently, the consequences of missing tolerances or welding vent holes poorly are practically nonexistent. The consequences for testable, WT Ultra joints would be much greater.

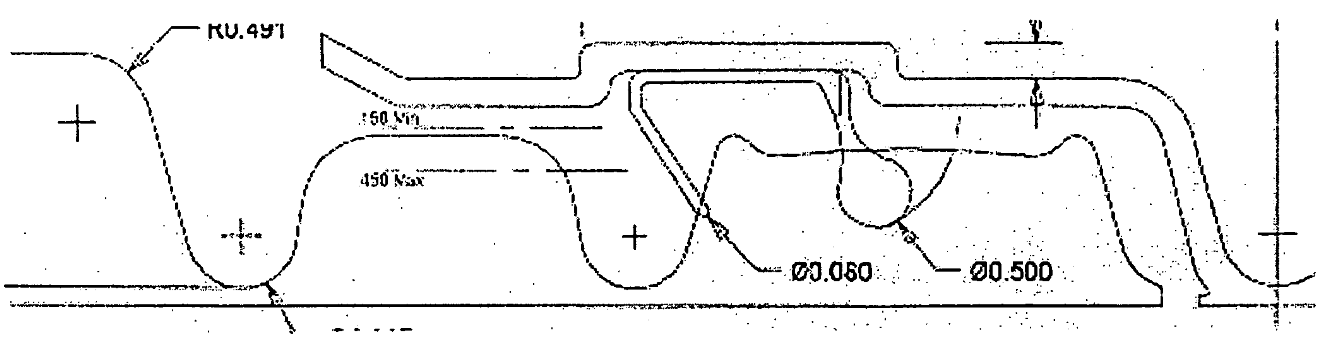
Two (of many) Alternative Approaches to WT IB Joint Performance

"Conventional" Approach



- Full size spigot corrugations and conventional valley gasket
- Larger ID Bell and Larger Lead-In
- External Reinforcing Band for Added Bell Strength
- Added Downstream Operation - More difficult storage and installation with larger bell
- Guaranteed to Work
- Could design with ST and WT options so Bell Tooling would not have to Change

Coextruded Bell Gasket Approach



- Capture Gasket and Bell Reinforcing Ring in Bell ID
- Likely to Require Mini-Corrugation Spigot and Bell OD larger than Pipe (Not Shown) - Overall Bell OD likely smaller than "Conventional" approach because Lead-In no Longer is Critical
- More Testing / Development than "Conventional" Approach
- Cost Efficient but Limited to Single Gasket Supplier
- Novel Restrained Joint
- Only Gasket Changes between ST and WT Versions